

## PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-178170

(43)Date of publication of application : 25.06.2002

(51)Int.Cl.

B23K 20/12

C22C 21/00

C22C 21/02

C22C 21/06

C22C 21/10

// B23K101:18

B23K103:10

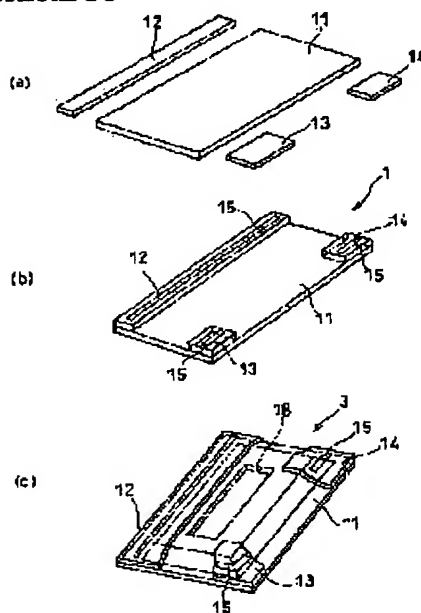
(21)Application number : 2000-385752

(71)Applicant : KOBE STEEL LTD

(22)Date of filing : 19.12.2000

(72)Inventor : MATSUMOTO KOICHI

### (54) DIFFERENT THICK BLANK, AND MANUFACTURING METHOD THEREOF



#### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a different thick blank for improving press moldability and reliability in mass production, and a manufacturing method thereof.

**SOLUTION:** Two corner parts forming the ends of one long side of a reinforcing plate 12 are disposed on two corner parts forming the ends of one long side of a main plate 11, the respective corner parts of reinforcing plates 13 and 14 are disposed on the remaining two corner parts of the main plate 11, and the reinforcing plates 12 to 14 are stacked on the main plate 11. Adhesive (not shown) made of nylon epoxy resin, etc., is preferably applied between the reinforcing plates 12 to 14 and the main plate 11. A plurality of joined parts 15 are formed by joining the reinforcing plates 12 to 14 with

the main plate 11 at a plurality of parts by the friction stirring welding(FSW). As a result, the main plate 11 is integrated with the reinforcing plates 12 to 14 to form a different thick blank 1.

## CLAIMS

---

[Claim(s)]

[Claim 1] A main plate material of one sheet which is a difference thickness blank material which has a part where board thickness differs mutually, and is processed by press forming, and consists of aluminum or an aluminum alloy, A difference thickness blank material, wherein it is unified by friction stir joining and back-up-plate material and \*\* which consisted of aluminum or an aluminum alloy and were laminated on said main plate material are formed.

[Claim 2] The difference thickness blank material according to claim 1 characterized by a thing which said main plate material and said back-up-plate material pasted, and which is done for back friction stir joining.

[Claim 3] The difference thickness blank material according to claim 1 or 2, wherein a joined part toward which said friction stir joining is performed in an end of said back-up-plate material, and the surface inclines to the surface of said main plate material between the end and surface of said main plate material is formed.

[Claim 4] A difference thickness blank material given in any 1 paragraph of claims 1 thru/or 3, wherein a member after said press forming has a part of at least 1 chosen from a group which consists of an opening and an uneven part.

[Claim 5] A difference thickness blank material given in any 1 paragraph of claims 1 thru/or 4 using as an interior panel of a car after said press forming.

[Claim 6] Said main plate material and said back-up-plate material 3000 system, respectively An aluminum alloy, A difference thickness blank material given in any 1 paragraph of claims 1 thru/or 5 consisting of an aluminum alloy and a kind of aluminum alloy chosen from an aluminum alloy and a group which consists of aluminum alloys 7000 system 6000 system 5000 system.

[Claim 7] A manufacturing method of a difference thickness blank material characterized by comprising the following.

A process of laminating back-up-plate material which consists of aluminum or an aluminum alloy on a main plate material of one sheet which consists of aluminum or an aluminum alloy.

A process of carrying out friction stir joining of said main plate material and said back-up-plate material.

## DETAILED DESCRIPTION

---

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the difference thickness blank material which aimed at control of the crack at the time of press forming especially about the difference thickness blank material of suitable aluminum for the interior panel of a car, or the product made from an aluminum alloy.

[0002]

[Description of the Prior Art] The art of manufacturing the steel plate of one sheet is indicated by JP, 10-180470, A, for example by comparing the end face of two or more steel plates, and joining by welding. Thus, the manufactured plate is called the tailored blank material.

After being unified by junction, it is processed into specific member shape, for example by press forming.

[0003]According to such a tailored blank material, by using a high strength material or a thick steel plate for the portion as which high intensity is required, even if it does not use a reinforcing member separately, it becomes possible to secure required intensity and rigidity. Since the yield of material improves by using an end material for some of two or more steel plates joined, the number of metallic molds can be decreased, and it becomes possible to manufacture a required member by low cost. Since thick distribution can be optimized easily, the lightest-weight member can be obtained securing required intensity and rigidity.

[0004]Thus, there are various effects in a tailored blank material, and it is already put in practical use about the steel plate. For this reason, application to aluminum or the aluminum alloy plate (henceforth [ aluminum and an aluminum alloy are named generically and ] aluminum) which is superior to the steel plate in respect of the weight saving is also considered. For example, the trial which carries out press forming of the tailored blank material which joined the aluminum plate and was manufactured, and makes the member of desired shape profitably like is made.

[0005]

[Problem(s) to be Solved by the Invention]However, the actual condition is that accumulation of the knowledge like a steel plate is not made about the press-forming nature of an aluminum plate. When steel plates are compared and welded, the intensity of a weld zone becomes higher than a base material, but when butt welding of the aluminum plates is carried out, the direction of the intensity of a weld zone becomes low. Specifically, it is only 60 thru/or about 80% in the aluminum alloy plate of 5000 systems or 6000 systems to the value of  $x(\text{proof stress of the proof stress/base material of a weld zone})$  100 (%) being about 150% in a steel plate. For this reason, since the intensity of that portion is low when the weld zone is contained to the part to which tension is added at the time of press forming, the deformation of a weld zone becomes larger than other parts. With an aluminum plate, about 50 percent of the things of only a base material, and since the elongation after fracture of the portion containing a weld zone is small, a crack (fracture) mainly produces it in a weld zone in many cases in the middle of press forming. Therefore, depending on carrying out press forming of the tailored blank material manufactured by the same method as the case of a steel plate by carrying out butt welding of two or more aluminum plates, only the product of the easy shape where molding height is low can be made.

[0006]For this reason, when carrying out butt welding of the aluminum alloy plate and manufacturing a tailored blank material, it is common to make it the place which the deformation by press forming left distantly [ corner part / which becomes intense ] become a joined part. However, only the effect that the restriction to the formation position of a weld zone and the shape of the tailored blank material itself is large, and it is lower than the case where it is a steel plate, in this case is acquired.

[0007]Since intensity is remarkably changed by whether a weld flaw exists in a weld zone when aluminum plates are compared by welding and it joins, there is also a problem that the reliability at the time of mass production is low.

[0008]This invention was made in view of this problem, and is \*\*\*\*. The purpose is to provide a difference thickness blank material which can raise a sex and the reliability at the time of mass production, and a manufacturing method for the same.

[0009]

[Means for Solving the Problem]A main plate material of one sheet which a difference thickness blank material concerning this invention is a difference

thickness blank material which has a part where board thickness differs mutually, and is processed by press forming, and consists of aluminum or an aluminum alloy, It is unified by friction stir joining and back-up-plate material and \*\* which consisted of aluminum or an aluminum alloy and were laminated on said main plate material are formed.

[0010]In this invention, required intensity and rigidity are securable only with a main plate material by providing back-up-plate material in a part which runs short of intensity and rigidity, controlling weight increase. Under the present circumstances, since a main plate material of one sheet which consists of a single plate unlike a tailored blank material constituted by comparing a plate of two or more sheets exists over the whole surface, it is very hard to produce a crack at the time of press forming, and even if molding height is a comparatively high member, it becomes possible to fabricate easily. Therefore, since there is almost no restriction to a joint part, it is possible to optimize freely not only thickness of a main plate material and back-up-plate material but a place which performs friction stir joining according to intensity and rigidity which are demanded. It is also possible to also use an end material for back-up-plate material and to raise a material yield and to reduce cost, since it is possible. Back-up-plate material of two or more sheets may be laminated by one place.

[0011]Since friction stir joining of the back-up-plate material is carried out to a single main plate material, even if a part of joined part has a defect, it is possible for intensity not to fall too much by making this into a cause, and to acquire high reliability. When a board thickness difference for every part is large, manufacture is difficult what is depended on the conventional comparison, but since it is formed by performing friction stir joining after lamination in this invention, it can manufacture easily.

[0012]A thing which said main plate material and said back-up-plate material pasted and which is done for back friction stir joining is preferred. Since a main plate material and back-up-plate material will touch not on the end face but on the surface of a comparatively large area, the reliability of junction not only improves, but vibration resistance improves by adhesion by adhesives. In this case, as adhesives, a polyvinyl alcohol system, a rubber system, epoxy, an acrylic, polyester, polyamide, etc. can be used, for example.

[0013]If a joined part toward which said friction stir joining is performed in an end of said back-up-plate material, and the surface inclines to the surface of said main plate material between the end and surface of said main plate material is formed, Since change of shape between a portion in which back-up-plate material is provided, and a portion which is not provided becomes comparatively gently-sloping, stress concentration to a portion in which back-up-plate material of a main plate material is not provided is eased, and it becomes much more difficult to produce a crack at the time of press forming.

[0014]A member after said press forming may have a part of at least 1 chosen from a group which consists of an opening and an uneven part. Such an opening and an uneven part may be beforehand formed, before laminating to a main plate material and/or back-up-plate material, and they may be formed simultaneous or after that with said press forming after friction stir joining. An uneven part may be repeatedly formed along with one direction or a 2-way which crosses mutually, for example of embossing.

[0015]A difference thickness blank material concerning this invention may be used after said press forming again as an interior panel of a car, for example, an inner

panel of a door, a panel of a backdoor, a side panel, a floor side panel, etc.

[0016]As for said main plate material and said back-up-plate material, it is preferred respectively an aluminum alloy and to consist of an aluminum alloy and a kind of aluminum alloy chosen from an aluminum alloy and a group which consists of aluminum alloys 7000 system 6000 system 5000 system 3000 system. Not only JIS but a thing to depend on AA Standard is contained in "3000 System", "5000 systems", "6000 systems", and "7000 systems." Especially an aluminum alloy is excellent in respect of the recycling characteristic 6000 system among these aluminum alloys. Although content of an aluminum alloy of Mg is a thing more than 4 mass % 5000 system and Si contains an aluminum alloy within fixed limits other than Mg 6000 system in AA or JIS, Content of each constituent element can not necessarily be suitably changed, even if it does not enter within the limits of a standard. That is, other elements may contain according to a concrete use and the characteristic demanded. They may be products made from an aluminum alloy, such as 1000 systems or 3000 systems.

[0017]A manufacturing method of a difference thickness blank material concerning this invention has the process of carrying out friction stir joining of a process of laminating back-up-plate material which consists of aluminum or an aluminum alloy on a main plate material of one sheet which consists of aluminum or an aluminum alloy, and said main plate material and said back-up-plate material.

[0018]

[Embodiment of the Invention]Hereafter, a difference thickness blank material concerning the example of this invention and a manufacturing method for the same are concretely explained with reference to an attached drawing. Drawing 1 (a) thru/or (c) is a perspective view showing the difference thickness blank material concerning the 1st example of this invention, its manufacturing method, and a processing method at process order. Drawing 2 is a sectional view showing some difference thickness blank materials manufactured by the 1st example.

[0019]In the 1st example, as shown in drawing 1 (a), a difference thickness blank material is manufactured using the main plate material 11 of one sheet, and the back-up-plate material 12 thru/or 14 of three sheets. Each of these plates is the products made from an aluminum alloy 6000 system, for example. The main plate material 11 has rectangular shape, and the board thickness is uniform. The back-up-plate material 12 also has rectangular shape, that of the length is equal to it of the main plate material 11, and that of the width is narrower than the thing of the main plate material 11, for example, is about 1/5. The back-up-plate material 13 and 14 also has rectangular shape, and the length and width are smaller than the thing of a main plate material, for example, are about 1/5.

[0020]First, as shown in drawing 1 (b), alignment of the two corners which are ends of the merits neighborhood of the back-up-plate material 12 is carried out to two corners which are ends of the merits neighborhood of the main plate material 11, Alignment of the one corner each of the back-up-plate material 13 and 14 is carried out to the two remaining corners of the main plate material 11, and the back-up-plate material 12 thru/or 14 is laminated on the main plate material 11. At this time, it is preferred to apply the adhesives made of a nylon epoxy resin (not shown), for example between the back-up-plate material 12 thru/or 14 and the main plate material 11.

[0021]Then, as shown in drawing 1 (b) and drawing 2, two or more joined parts 15 are formed by joining two or more back-up-plate material 12 thru/or 14 and main plate materials 11 by friction stir joining (FSW) in a part, respectively. As a result,

the main plate material 11 and the back-up-plate material 12 thru/or 14 are unified, and the difference thickness blank material 1 is formed.

[0022]Subsequently, as shown in drawing 1 (c), the member 3 for panels is formed by press forming, for example by forming heights in the center section of the difference thickness blank material 1, for example. Trimming etc. are given to the periphery of the member 3 for panels, and it is made desired shape.

[0023]Thus, since according to the 1st example friction stir joining of the back-up-plate material 12 thru/or 14 is carried out on the surface of the main plate material 11 and the difference thickness blank material 1 is manufactured, Even if it is a case where the difference of the board thickness for every part makes a large blank material profitably like as compared with the tailored blank material manufactured by butt welding, it can manufacture easily. In the difference thickness blank material 1, since the main plate material 11 which comprised a single plate over the whole surface exists, it is very hard to produce a crack also by press forming, and a comparatively high [ molding height ]-shaped member (for example, interior panel of a car) can be obtained easily. Since an end material can also be used depending on the shape and the size of the back-up-plate material 12 thru/or 14, it is also possible to make the yield of material high and to reduce cost like the conventional tailored blank material. It is possible to obtain a thing comparable as the conventional tailored blank material at least also about a weight saving, intensity, and rigidity. Since friction stir joining of the back-up-plate material 12 thru/or 14 is carried out on the main plate material 11 of one sheet, even when the joined part 15 has a defect, the intensity of the difference thickness blank material 1 or the member 3 for panels cannot fall too much by the ability to make this into a cause, and high reliability can be secured.

[0024]Although the method of performing arc welding etc. is also mentioned as a method of joining the plate of two sheets, when it joins by friction stir joining like this example, there are following various advantages. First, since the filler metal is unnecessary, the presentation of a joined part hardly changes from the presentation of a base material. For this reason, it will become easier to estimate the intensity of a weld zone, etc. Although arc welding cannot be performed to all aluminum alloys, friction stir joining can be carried out no matter what presentation it may be.

Although arc welding can be carried out only to the circumference of back-up-plate material, friction stir joining can be carried out to the central part of back-up-plate material, etc., as shown in drawing 1 (b). That is, the flexibility of a joint part is large. Therefore, it is possible to choose a joint part in consideration of the stress distribution in bendings, such as subsequent press forming, etc., etc.

[0025]The opening 18 may be formed in the member 3 for panels as shown in drawing 1 (c). Before this opening 18 carries out friction stir joining of the main plate material 11 and the back-up-plate material 12, it may be formed in the main plate material 11, and it may be formed before press forming after friction stir joining. An uneven part (not shown) may be formed in the member 3 for panels. This uneven part may also be formed simultaneously with press forming, and may be formed according to a separated process before and after that.

[0026]In particular the plane shape and construction material of a main plate material and back-up-plate material are not limited. When press forming etc. are preferably performed to the position which provides back-up-plate material after that, it is a position for which strong reinforcement is needed, and the board thickness of back-up-plate material can be suitably adjusted with what intensity is needed for the part. The member obtained again by carrying out press forming of the difference thickness

blank material 1 is not limited to the member for panels.

[0027]After performing friction stir joining, arc welding etc. may perform a fillet weld etc. further for the purpose of the superiors for reliability.

[0028]Next, the 2nd example of this invention is described. Drawing 3 (a) thru/or (c) is a perspective view showing the difference thickness blank material concerning the 2nd example of this invention, its manufacturing method, and a processing method at process order.

[0029]In the 2nd example, as shown in drawing 3 (a), a difference thickness blank material is manufactured using the main plate material 21 of one sheet, and the back-up-plate material 22 of one sheet. Each of these plates is the products made from an aluminum alloy 6000 system like the 1st example, for example. The board of rectangular shape has the shape crooked in the longitudinal direction at two places, i.e., the shape of the shape of "KO", and the main plate material 21 of the board thickness is uniform. Although the back-up-plate material 22 also has the shape of the shape of "KO", the width is narrower than the thing of the main plate material 21, for example, is  $\frac{1}{3}$  thru/or about  $\frac{1}{2}$ . In the following explanation, an inner surface and an outside field are called outside surface for the field inside the shape shape of "KO."

[0030]First, as shown in drawing 3 (b), alignment is carried out to two flections in the outside surface of the two flection main plate materials 11 in the inner surface of the back-up-plate material 22, and it laminates on the back-up-plate material 22 main plate materials 21. At this time, it is preferred to apply the adhesives made of a nylon epoxy resin (not shown) like the 1st example between the back-up-plate material 22 and the main plate material 21, for example.

[0031]Then, as shown in drawing 3 (b), two or more joined parts 25 are formed by joining the back-up-plate material 22 and the main plate material 21 by friction stir joining at two or more places. As a result, the main plate material 21 and the back-up-plate material 22 are unified, and the difference thickness blank material 2 is formed.

[0032]Subsequently, as shown in drawing 3 (c), the shape member 4 of "KO" is formed by forming the crevice 24 in the center section of the field which is not covered with embossing (press forming) at the back-up-plate material 21 by the appearance of the portion pinched by two flections of the main plate material 21, for example. Predetermined processing is performed to the shape member 4 of "KO", and it is made desired shape.

[0033]Thus, since according to the 2nd example friction stir joining of the back-up-plate material 22 is carried out on the surface of the main plate material 21 and the difference thickness blank material 2 is manufactured, it is very hard to produce a crack also by press forming, and the member possessing the crevice 24 where the depth is comparatively deep can be obtained easily. It is also possible to be able to use an end material depending on the shape and the size of the back-up-plate material 22 as well as the conventional tailored blank material, to make the yield of material high like the 1st example, and to reduce cost. It is possible to obtain a thing comparable as the conventional tailored blank material at least also about a weight saving, intensity, and rigidity. Since friction stir joining of the back-up-plate material 22 is carried out on the main plate material 21 which consists of a single plate, even when the joined part 25 has a defect, the intensity of the difference thickness blank material 2 or the shape member 4 of "KO" cannot fall too much by the ability to make this into a cause, and high reliability can be secured.

[0034]Next, the 3rd example of this invention is described. Drawing 4 is a top view

showing the difference thickness blank material concerning the 3rd example of this invention.

[0035]Friction stir joining is pasted up and carried out, and, as for the difference thickness blank material 5 concerning the 3rd example, the three back-up-plate material 32 thru/or 34 is constituted by the one main plate material 31. The back-up-plate material 32 thru/or 34 is joined to the main plate material 31 at two or more places, and two or more joined parts 35 are formed. And the crevice 36 of two or more conical shape (cone shape) which projects on the surface of an opposite hand with the surface to which the back-up-plate material 32 thru/or 34 of the main plate material 31 was joined is formed of press forming, and an inner panel is manufactured. Then, two or more crevices 36 are joined to an outer panel via resin in each crowning of said opposite side surface.

[0036]Also in this example, since friction stir joining of the back-up-plate material 32 thru/or 34 is carried out on the surface of the main plate material 31 which consists of a plate of one sheet and the difference thickness blank material 5 is manufactured, it is very hard to produce a crack also by press forming, and the member possessing the crevice 36 where the depth is comparatively deep can be obtained easily. It is also possible to acquire the same effect as the 1st and 2nd examples.

[0037]In the 1st thru/or the 3rd example, although friction stir joining is performed in the center section of back-up-plate material, etc., friction stir joining may be performed by a boundary part with the main plate material of back-up-plate material. Drawing 5 is a sectional view showing the joined part at the time of performing friction stir joining by a boundary part with the main plate material of back-up-plate material.

[0038]When friction stir joining is performed by a boundary part with the main plate material 41 of the back-up-plate material 42, as shown in drawing 5, the right-angled portion which existed in the corner of the back-up-plate material 42 by the joined part 45 is lost, and the surface of the joined part 45 turns into a field sloping to the surface of the main plate material 41. For this reason, the stress concentration to the part in which the back-up-plate material 42 of the main plate material 41 is not formed is eased, and it becomes much more difficult to produce the crack at the time of press forming in this part.

[0039]Hook-like heights may be formed in the end of back-up-plate material. If such heights are formed, it can position easily by the ability to make these heights engage with the side of a main plate material. Extrudate can be used for such back-up-plate material, for example.

[0040]

[Effect of the Invention]As explained in full detail above, according to this invention, required intensity and rigidity are securable only with a main plate material by providing back-up-plate material in the part which runs short of intensity and rigidity, controlling weight increase. Under the present circumstances, since the main plate material of one sheet which consists of a single plate unlike the tailored blank material constituted by comparing the plate of two or more sheets exists over the whole surface, it is very hard to produce a crack at the time of press forming, and even if molding height is a comparatively high member, it can fabricate easily. Therefore, since there is almost no restriction to a joint part, according to the intensity and rigidity which are demanded, not only the thickness of a main plate material and back-up-plate material but the place which performs friction stir joining can be optimized freely. Since it is also possible to use an end material for back-up-



plate material, a material yield can be raised and cost can also be reduced. Since friction stir joining of the back-up-plate material is carried out to a single main plate material, even if a part of joined part has a defect, intensity cannot fall too much by the ability to make this into a cause, and high reliability can be acquired. When the board thickness difference for every part is large, manufacture is difficult what is depended on the conventional comparison again, but since it is formed by performing friction stir joining after lamination according to this invention, it can manufacture easily. Since a main plate material and back-up-plate material contact in a comparatively large area, adhesives can be made to be able to intervene among them and reliability can be raised more.

[0041]The crack by the portion can be made much more hard to make the stress concentration to the portion in which back-up-plate material is not provided ease, and to produce, since the surface of a joined part turns into a field which was missing from the main plate material and inclined from back-up-plate material according to the invention concerning claim 3.